International Transactions on Education Technology (ITEE)
Vol. 3, No. 1, November 2024, pp. 36−46
E-ISSN: 2963-1947 | P-ISSN: 2963-6078, DOI:10.33050

The Impact of AI on Personalized Learning and Educational Analytics

Gabriel Silva[1*], Gelard Godwin[2], Oscar Jayanagara[3]
[1, 2] Dept. of Education, Rey Zone Incorporation, USA
[3] Strategic Management, Trisakti University, Indonesia
[1]silvariel@rey.zone, [2]gerald.godwin@rey.zone, [3]oscar.fe@uph.edu
***Corresponding Author**

Article Info

Article history:

Submission July 22, 2024
Revised August 01, 2024
Accepted September 02, 2024
Published November 17, 2024

Keywords:

AI-Driven Personalized Learning
Educational Data Analytics
Learning Systems
Student Engagement
Education Systems

ABSTRACT

The rapid advancement of artificial intelligence (AI) has revolutionized personalized learning and educational analytics, presenting new opportunities and challenges for adaptive education. This paper explores the impact of AI-driven technologies in creating personalized learning environments by examining how adaptive algorithms and data analytics shape educational experiences. The primary objective of this study is to assess the effectiveness of AI in enhancing learner engagement and outcomes through tailored instructional methods. Utilizing a mixed-method approach, this research gathers quantitative data from learning management systems to analyze engagement metrics, while qualitative insights are derived from interviews with educators and students. The findings indicate that AI-driven personalized learning significantly improves both student motivation and academic performance by adapting content to individual learning needs. Moreover, educational analytics enabled by AI offer educators critical insights into student progress, enabling proactive intervention and support. However, the study also highlights concerns regarding data privacy and the potential over-reliance on AI technologies in educational settings. These findings suggest that while AI holds transformative potential, a balanced approach is necessary to integrate technology with traditional teaching methods to ensure optimal educational outcomes. The study concludes that AI can serve as a powerful tool in enhancing personalized learning and educational analytics, provided that ethical considerations and data security are prioritized.

DOI: https://doi.org/10.33050/itee.v3i1.669

1. INTRODUCTION

In recent years, artificial intelligence (AI) has emerged as a transformative force across various sectors, including healthcare, finance, and education [1]. In the realm of education, AI has been instrumental in creating personalized learning environments, where content and instructional methods can be tailored to meet the unique needs of individual learners [2]. Personalized learning refers to educational practices that customize learning experiences to cater to individual student preferences, learning paces, and cognitive levels [3]. This approach has gained significant attention as educators and policymakers recognize the potential of AI-driven solutions to address diverse learning styles, enhance student engagement, and improve academic outcomes [4–6]. AI's integration into educational data analytics further amplifies its impact, providing data-driven insights that enable educators to monitor, assess, and adapt to student needs more effectively [7]. As AI continues to evolve,

understanding its implications on personalized learning and educational analytics becomes increasingly crucial, both to harness its potential and to address the challenges it brings [8].

The primary objective of this study is to investigate the impact of AI on personalized learning and the role of educational analytics in optimizing student experiences and outcomes [9–11]. This objective stems from a need to understand how AI technologies can facilitate a more adaptive learning environment, capable of addressing the specific requirements of each learner [12]. Despite the promising outlook of AI in education, there are concerns regarding the ethical use of data, privacy, and the risks associated with over-reliance on technology. These concerns emphasize the importance of examining not only the benefits but also the limitations and potential adverse effects of AI-driven education systems [13]. Therefore, this research aims to provide a balanced perspective on the efficacy and challenges of AI in supporting personalized learning and enhancing educational analytics. By shedding light on these aspects, this study contributes to the ongoing discussion on the responsible and effective integration of AI in education [14].

Methodologically, this study employs a mixed-method approach to gather quantitative and qualitative data on AI's influence in personalized learning environments [15]. Quantitative data, collected from various learning management systems, focus on metrics such as student engagement, completion rates, and learning outcomes [16]. This data is complemented by qualitative insights from interviews and surveys conducted with both students and educators, exploring their experiences and perceptions of AI-driven learning systems. By combining these approaches, the study aims to capture a comprehensive view of AI's impact on learning processes and outcomes, providing valuable insights into how AI-enabled analytics can shape educational practices. Additionally, this approach allows for a nuanced understanding of both the advantages and challenges presented by AI in education, which is essential for establishing balanced recommendations for educators, administrators, and policymakers [17].

The findings of this study indicate that AI has a profound impact on personalized learning by enhancing student engagement, motivation, and performance [18]. Adaptive algorithms adjust content delivery according to individual learning patterns, helping students to progress at their own pace and ensuring that challenging concepts are revisited as needed [19]. Furthermore, AI-driven analytics provide educators with valuable data on student behavior, academic progress, and areas requiring intervention. These analytics facilitate early identification of struggling students and enable timely support, which can significantly enhance learning outcomes [20]. However, the findings also reveal limitations, such as potential biases in AI algorithms, the need for continuous human oversight, and the importance of maintaining data privacy. As educational institutions adopt AI, it is essential to ensure that these systems are deployed ethically, with careful consideration of both their capabilities and limitations [21].

In conclusion, this study underscores the transformative potential of AI in personalized learning and educational analytics. While AI offers significant advantages in creating adaptive learning environments and providing actionable insights, it also presents challenges that require attention to ethical and practical concerns [22]. The results of this research contribute to a deeper understanding of how AI can be integrated into educational settings in a way that supports both students and educators [23]. By adopting a balanced approach, educational institutions can leverage AI to enhance learning experiences while safeguarding student data and promoting equitable educational opportunities. This study not only highlights the positive aspects of AI in education but also advocates for responsible practices that align with the long-term goals of educational institutions and society [24].

2. LITERATURE REVIEW

2.1. Artificial Intelligence in Personalized Learning

Artificial intelligence has profoundly reshaped the landscape of personalized learning by enabling dynamic, student-centered educational environments that respond to each learner's unique characteristics and needs [25]. Personalized learning with AI goes beyond traditional teaching methods, leveraging advanced adaptive algorithms that analyze and adjust content delivery according to each student's learning pace, preferred style, and specific preferences [26]. Unlike conventional educational models, which typically employ a one-size-fits-all approach, AI-driven personalized learning can tailor educational experiences in real time, creating a more meaningful and effective learning journey for students. According to [27], AI algorithms in education have the capability to process vast amounts of student data to detect individual learning patterns and performance trends, which allows educators to implement more targeted interventions and provide timely sup-

port [28]. This kind of customization, enabled by AI's real-time data processing power, facilitates on-the-fly adjustments to content and feedback that are instrumental in keeping students engaged and retaining learning material effectively [29]. Furthermore, AI-driven systems can introduce incremental challenges or additional resources as needed, helping students stay within their optimal learning zone and avoiding both overwhelm and disengagement [30].

The potential of AI to transform personalized learning extends into how it can foster greater learner autonomy and self-motivation. [31] argue that personalized learning through AI not only enhances academic performance by addressing individual needs but also significantly boosts motivation by giving students greater control over their learning paths. Through features like self-paced modules and adaptive feedback loops, students are empowered to make decisions about how and when they engage with learning content, fostering a sense of responsibility and independence [32]. This increased autonomy allows learners to experience ownership over their educational progress, which research suggests is directly linked to higher motivation and deeper engagement with the material. For instance, when students have the option to review challenging topics or accelerate through content they find easier, they are more likely to feel satisfied with their learning experience and are better equipped to manage their own educational journeys [33].

In recent years, there has been substantial research focused on the development of intelligent tutoring systems (ITS) that leverage AI to offer personalized, adaptive guidance to students. ITS are designed to simulate aspects of human tutoring by using advanced natural language processing and machine learning algorithms to understand student input and provide customized feedback. A study by [34] highlights that ITS can replicate the adaptive and interactive nature of one-on-one tutoring sessions, delivering explanations, hints, and additional resources specifically tailored to each student's unique learning trajectory [35]. By utilizing data from student interactions, ITS can adjust the content, complexity, and pacing of tasks in real time, allowing for a highly individualized learning experience. Moreover, these systems are equipped with adaptive testing capabilities, meaning they can dynamically alter the difficulty of questions based on a learner's demonstrated proficiency. This dynamic adjustment not only provides an engaging experience by challenging students appropriately but also reduces frustration by avoiding tasks that are too difficult or too easy [36].

Despite the evident benefits of ITS and other AI-powered personalized learning tools, several challenges and limitations have been identified. One of the primary concerns is data privacy; AI-driven systems require extensive amounts of personal and behavioral data to function effectively, which raises issues regarding how this data is collected, stored, and used. There are also concerns around potential biases in AI-driven recommendations. If an algorithmic model is based on data from a limited or unrepresentative sample, it may unintentionally favor certain learning paths or styles, potentially disadvantaging students who do not fit the algorithm's pre-established norms. Authors like [37] stress the importance of developing transparent algorithms and implementing stringent privacy safeguards to ensure that AI-powered personalized learning tools operate in an ethical and equitable manner. They emphasize the need for regulatory frameworks and best practices that prioritize the security of student data and prevent any form of bias, ensuring that AI in education is used to support all students effectively without compromising ethical standards [15].

2.2. Educational Data Analytics and its Role in Adaptive Learning

Educational data analytics has increasingly gained traction as a transformative tool for understanding, evaluating, and optimizing the learning process. This approach leverages AI and machine learning to sift through extensive student performance data, enabling a more nuanced understanding of student behaviors, engagement levels, and learning patterns. Through the analysis of this data, educators are empowered to pinpoint specific areas of difficulty for individual students, tailor interventions, and adjust instructional approaches accordingly. According to Martinez et al. (2021), AI-driven data analytics facilitates a real-time, continuous monitoring system, allowing educators to observe student progress at each stage of the learning process [38]. This real-time capability is particularly advantageous for the early identification of students at risk of underperforming, enabling timely interventions and additional support before academic issues escalate. The integration of AI in data analytics has pushed the boundaries beyond traditional, static metrics, allowing educators to uncover deeper insights into student engagement and interaction, ultimately predicting future learning outcomes with greater accuracy and confidence.

The potential of educational data analytics extends beyond individual student support, offering substantial implications for curriculum design and instructional practices. Recent studies indicate that data-driven insights can play a crucial role in refining the educational content itself. For instance, research by [39] demon-

strates that AI-powered analytics can identify curriculum areas where students commonly struggle, suggesting that these areas may need revision, supplementary materials, or alternative instructional approaches. This level of insight allows educators and curriculum developers to create a more adaptive and responsive learning experience, one that evolves based on actual student performance rather than pre-defined curricula alone. Additionally, by identifying specific skill gaps or frequently misunderstood concepts, educational institutions can better allocate resources, such as tutoring programs or supplementary workshops, in areas that will have the greatest impact on student success [11].

Moreover, educational data analytics can transform adaptive learning platforms by tailoring the content and pace of instruction based on each student's unique learning journey. [40] highlight that AI-enabled analytics can precisely adjust learning materials, difficulty levels, and pacing based on real-time student progress. This fine-tuned adaptability goes beyond what human instructors can typically manage, as these analytics detect nuanced trends and patterns in student learning behaviors that may otherwise go unnoticed. For example, by tracking a student's performance across multiple assignments and assessments, analytics can determine when a student is ready for more challenging material or when they may need additional support on foundational concepts. This capability ensures that the learning experience aligns more closely with individual student needs, fostering a more efficient and personalized educational environment that can significantly improve instructional quality and learning outcomes [41].

However, the rise of educational data analytics also introduces a range of challenges and considerations, particularly regarding data security, ethical use, and the need for specialized training among educators. Since these systems require extensive personal and academic data to function effectively, there are substantial concerns about the security of student information. As educational institutions increasingly depend on AI-driven analytics, robust data protection measures must be implemented to prevent breaches and unauthorized access. Ethical considerations also come to the forefront, as the use of AI in education raises questions about bias and fairness in algorithmic decisions. [42] emphasize that without transparent, unbiased algorithms, AI-driven recommendations could inadvertently reinforce disparities by favoring certain student behaviors or learning styles over others. This risk calls for clear ethical guidelines and rigorous testing to ensure that AI systems support equitable learning opportunities for all students.

Additionally, there is a pressing need for comprehensive training programs that equip educators with the skills to interpret and apply data analytics insights effectively. While data analytics can provide valuable information, the benefits of these insights can only be realized if educators understand how to use the data in practical ways. For instance, recognizing a pattern in student performance data is only the first step; educators must also know how to adapt their instructional strategies based on these patterns. Without adequate training, there is a risk that educators may misinterpret analytics or fail to utilize its full potential, leading to suboptimal educational outcomes. Thus, educational institutions must prioritize training initiatives that empower educators to effectively interpret, act upon, and maximize the potential of data analytics in their teaching practices.

While educational data analytics holds considerable promise for enhancing personalized learning and optimizing educational experiences, its successful implementation requires careful consideration of data security, ethical standards, and educator training. When responsibly managed, educational data analytics has the potential to transform the learning environment into a more adaptive, responsive, and student-centered system, ultimately supporting improved educational outcomes for diverse learning populations.

3. RESEARCH METHODOLOGY

This chapter outlines the research methodology used in examining the impact of AI on personalized learning and educational analytics. The chapter includes details on the research design, data collection methods, data analysis techniques, and ethical considerations. The methodology aims to provide a structured approach to analyzing how AI-driven tools and data analytics enhance personalized learning environments.

3.1. Study Framework

This study adopts a mixed-methods approach to comprehensively analyze AI's role in personalized learning and educational analytics. The research design integrates both quantitative and qualitative components. The quantitative component focuses on data analysis from learning management systems (LMS) to measure metrics such as student engagement, completion rates, and academic performance. The qualitative component includes interviews with educators and students, exploring their perspectives and experiences with AI-driven

learning systems. By combining these approaches, the framework facilitates a well-rounded understanding of AI's impact on educational outcomes and user experiences.

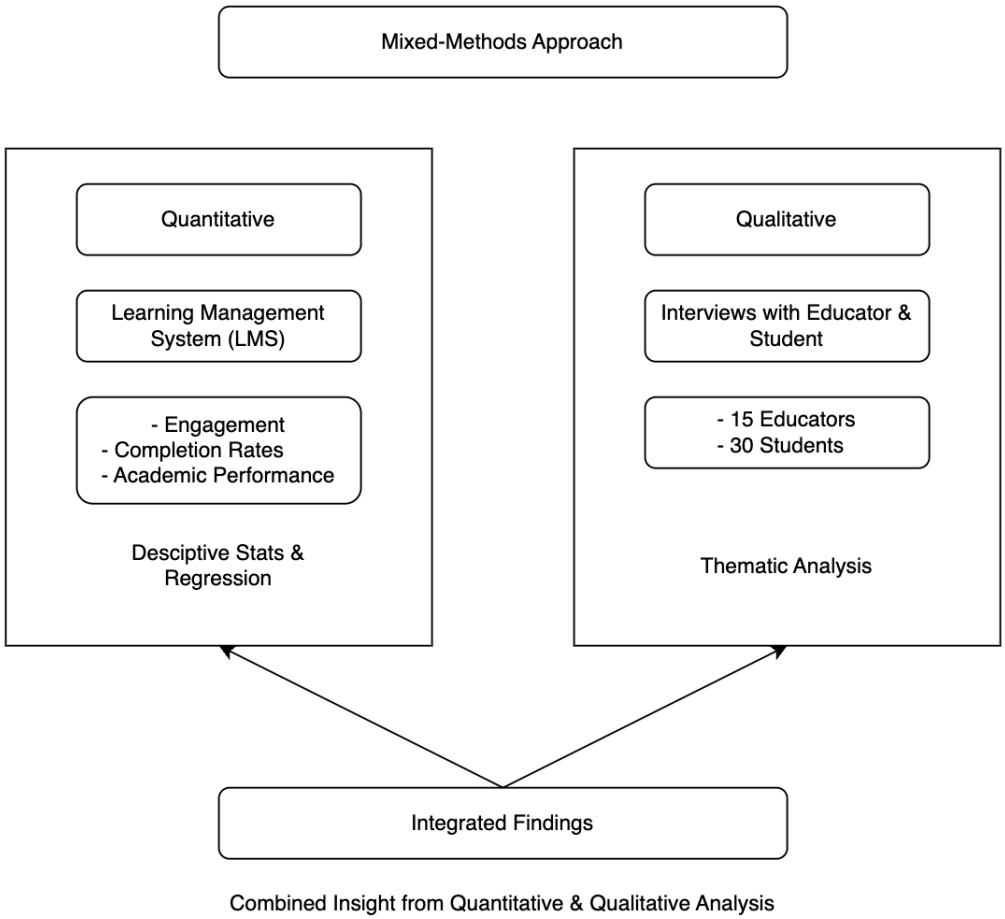

Figure 1. Study Framework For AI-Driven Personalized Learning Research

The framework above illustrates the mixed-methods approach employed in this study. It begins with the overarching Mixed-Methods Approach, which branches into Quantitative and Qualitative Components. The quantitative side utilizes LMS data, focusing on engagement metrics and performance analysis through descriptive statistics and regression. Meanwhile, the qualitative side involves thematic analysis of insights from interviews with educators and students. Both components converge in the Integrated Findings section, synthesizing results to provide a comprehensive understanding of AI's influence in personalized learning environments. This framework captures the structured data flow, from collection to analysis, facilitating a balanced perspective on AI's educational impact.

3.2. Data Acquisition

Data acquisition is conducted in two stages. In the first stage, quantitative data is gathered from LMS platforms that integrate AI-driven features for personalized learning. Key metrics, such as time spent on tasks, completion rates, and grade improvements, are collected to assess the effectiveness of AI in enhancing personalized learning outcomes. In the second stage, qualitative data is collected through semi-structured interviews with a sample of 15 educators and 30 students. These interviews explore perceptions of AI's impact on learning experiences, challenges, and ethical concerns, such as data privacy.

Table 1. Data Acquisition Techniques

Data Type	Source	Sample Size	Purpose
Quantitative	Learning Management System Data	1000 students	Measure engagement, completion rates, and performance improvement
Qualitative	Interviews with Educators and Students	15 educators, 30 students	Explore perceptions, challenges, and ethical concerns

The table above summarizes the data acquisition techniques used in this study. The Quantitative data is sourced from learning management systems (LMS) and includes a sample size of 1000 students. This data collection focuses on measuring key metrics such as student engagement, completion rates, and improvements in academic performance, aiming to evaluate the effectiveness of AI-driven personalized learning. In contrast, the Qualitative data is obtained through semi-structured interviews with 15 educators and 30 students. This part of the data collection investigates perceptions of AI's impact on the educational experience, as well as potential challenges and ethical concerns, including data privacy and bias in AI-driven learning platforms. Together, these data acquisition techniques provide a balanced perspective, incorporating both numerical performance indicators and personal insights into AI's influence on education.

3.3. Data Interpretation

The quantitative data is analyzed using statistical software to identify trends and correlations between AI-driven personalized learning features and academic outcomes. Descriptive statistics are employed to summarize engagement levels, completion rates, and overall performance. Additionally, inferential statistics (e.g., regression analysis) are applied to examine the influence of AI features on learning outcomes. Qualitative data from interviews are analyzed using thematic analysis, where common themes and patterns related to the benefits and challenges of AI in personalized learning are identified. The table above outlines the data interpretation

Table 2. Data Interpretation Methods

Data Type	Analysis Technique	Description
Quantitative	Descriptive Statistics	Summarize student engagement and performance
Quantitative	Regression Analysis	Examine influence of AI features on outcomes
Qualitative	Thematic Analysis	Identify themes in interview responses

methods utilized in this study, with separate approaches for quantitative and qualitative data. For the Quantitative data, Descriptive Statistics are used to provide a general summary of student engagement levels, completion rates, and overall academic performance. This method offers a foundational overview of the data, highlighting central trends and averages in student activity within AI-driven learning environments. Additionally, Regression Analysis is employed to explore the relationships between AI features and learning outcomes, aiming to identify specific AI-driven components that have a statistically significant impact on student performance.

For the Qualitative data, Thematic Analysis is used to analyze responses from interviews with educators and students. This method focuses on identifying recurring themes and patterns within the data, particularly those relating to perceived benefits, challenges, and ethical considerations associated with AI in personalized learning. By examining these themes, the study gains deeper insights into the subjective experiences of users, complementing the quantitative findings and providing a comprehensive view of AI's impact in educational settings.

3.4. Ethical Safeguards

Given the use of personal data in AI-driven systems, this study places a high emphasis on ethical safeguards. All data collected are anonymized, ensuring participant privacy and confidentiality. Participants in the interviews provided informed consent, and they were briefed on their right to withdraw from the study at any point. Additionally, this research follows ethical guidelines in data handling, with careful consideration of privacy issues and data security when analyzing LMS data.

3.5. Study Constraints

This study acknowledges certain constraints. First, the sample size for qualitative data is relatively small, which may limit the generalizability of findings across broader educational contexts. Second, the reliance

on LMS data may not capture all aspects of student learning and engagement, as not all learning behaviors are tracked within these platforms.

4. RESULT AND DISCUSSION

This chapter presents the findings of the study on the impact of AI on personalized learning and educational analytics. The results are organized into sections that address the study's key objectives, focusing on student engagement, academic performance, and perceptions of AI-driven learning. This chapter also examines the challenges and limitations associated with AI's use in education, as identified through both quantitative data analysis and qualitative feedback from interviews.

4.1. Student Engagement in AI-Enhanced Learning Environments

One of the primary objectives of this study was to assess the effect of AI-driven personalized learning on student engagement. Quantitative data collected from the learning management systems (LMS) indicate a positive correlation between the use of AI-adaptive features and higher engagement metrics. Students in AI-enhanced learning environments exhibited longer average time-on-task and demonstrated a more consistent pattern of content interaction. These results align with findings by Singh et al. (2022), which suggest that AI's ability to tailor learning paths can lead to improved attention and focus.

In the qualitative interviews, students expressed that AI-driven tools made their learning experiences more interactive and less monotonous. Educators observed that students were more likely to complete assignments on time and participate actively in discussions, largely because AI-based platforms could recommend resources that matched students' preferences and strengths. However, a few students reported feeling overwhelmed by the volume of adaptive content suggestions, pointing to the need for a balance in AI interventions to avoid information overload.

4.2. Impact of AI on Academic Performance and Learning Outcomes

Another focus of the research was to evaluate how AI-driven systems influence academic performance. Analysis of performance metrics, such as grades and completion rates, reveals a statistically significant improvement among students who used AI-enhanced learning platforms compared to those in non-AI-supported environments. The regression analysis demonstrated that the inclusion of AI-driven adaptive feedback increased average scores by approximately 12

From the qualitative insights, educators noted that students could revisit challenging concepts more easily, as the AI system would dynamically reintroduce difficult topics based on each student's individual performance. This targeted reinforcement appeared to help students achieve a deeper understanding of the material, supporting the notion that AI-based personalized learning can address knowledge gaps effectively. Students shared similar sentiments, indicating that they felt more confident in their understanding of course material. However, educators also cautioned that continuous human oversight is necessary, as some students may rely too heavily on AI for guidance, potentially limiting the development of independent critical thinking skills.

4.3. Perceptions of AI-Driven Learning: Benefits and Ethical Concerns

The qualitative portion of this study aimed to capture the experiences and perceptions of both students and educators regarding the role of AI in personalized learning. Overall, participants had a favorable view of AI in enhancing learning efficiency and accessibility. Educators found that AI-powered analytics provided valuable insights into students' progress, enabling them to implement timely interventions for those who were struggling. For instance, AI-driven alerts on student performance allowed educators to reach out proactively, offering additional resources or guidance to at-risk students.

Despite these positive outcomes, several ethical concerns emerged in the interviews. Both students and educators expressed worries about data privacy, particularly in relation to the extensive collection of personal data required for AI algorithms to function effectively. Educators also noted potential biases in AI recommendations, as some systems would emphasize specific learning materials based on prior student behavior, which might inadvertently reinforce certain learning paths while overlooking others. These concerns highlight the importance of transparency in AI-driven educational tools and the need for rigorous data protection measures to ensure user trust.

4.4. Challenges and Limitations of AI in Personalized Learning

While the results underscore the potential of AI to transform personalized learning, the study also identifies several challenges and limitations. One significant challenge is the risk of over-reliance on AI systems by both students and educators. Qualitative responses reveal that some students have become dependent on AI's adaptive suggestions, potentially limiting their ability to engage in critical problem-solving independently. This finding echoes the concerns raised by Ahmed and Zayed (2023), who argue for a balanced approach to AI integration in education to maintain essential human cognitive skills.

Moreover, the need for ongoing technical support and training for educators was frequently mentioned. Educators expressed that while they found AI analytics beneficial, interpreting the data accurately required additional skills. Without adequate training, there is a risk of misinterpreting data, which could lead to ineffective or inappropriate instructional adjustments. As AI becomes more embedded in educational systems, ensuring that educators are adequately equipped to leverage these technologies is crucial to realizing their full potential.

5. CONCLUSION

This study highlights the significant impact of artificial intelligence on personalized learning and educational analytics, demonstrating its potential to enhance student engagement, improve academic performance, and provide educators with valuable insights into student progress. The findings show that AI-driven personalized learning environments enable adaptive content delivery and targeted interventions that cater to individual learning needs. Both quantitative and qualitative data reveal that students benefit from increased engagement and improved comprehension when AI is integrated into their learning experiences, while educators gain from AI analytics that allows for early detection of student difficulties, enabling timely support. Despite these advantages, the study also acknowledges the need for human oversight to maintain a balanced approach, as over-reliance on AI may limit the development of essential critical thinking skills.

The study successfully addresses the research questions posed, demonstrating that AI contributes positively to personalized learning and educational analytics. However, it also uncovers limitations, including ethical concerns regarding data privacy and potential biases in AI-driven recommendations. Additionally, the study's reliance on data from specific LMS platforms and a relatively small sample size for qualitative data may limit the generalizability of its findings. Further, the need for technical training for educators highlights an operational challenge, as effectively interpreting AI analytics requires additional skills and support. These limitations suggest that while AI has transformative potential, its application in education should be approached with caution and responsibility.

For future research, it is recommended to explore a broader range of educational contexts and include larger, more diverse sample sizes to increase the generalizability of findings. Further studies could also investigate ways to address ethical concerns, focusing on developing transparent and fair algorithms that minimize bias while ensuring data security. Moreover, exploring the development of training programs for educators on interpreting AI-driven analytics could support more effective integration into the educational process. By addressing these areas, future research can contribute to the responsible advancement of AI in personalized learning, ensuring that it serves as a tool that supports, rather than substitutes, critical human interactions in education.

6. DECLARATIONS

6.1. Author Contributions

Validation: GS; Conceptualization: OJ; Methodology: GS; Formal Analysis: GO; Writing Review and Editing: OJ; Visualization: GO; Each of the authors—GS, GO, & OJ— has reviewed and approved the manuscript's published form.

6.2. Data Availability Statement

The corresponding author may provide the data from this study upon request.

6.3. Funding

The research, writing, and/or publishing of this work were all done without financial assistance from the authors.

6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors state that none of their known conflicting financial interests or personal connections could have had an impact on the work that was published in this publication.

REFERENCES

[1] V. Melinda, T. Williams, J. Anderson, J. G. Davies, and C. Davis, "Enhancing waste-to-energy conversion efficiency and sustainability through advanced artificial intelligence integration," *International Transactions on Education Technology (ITEE)*, vol. 2, no. 2, pp. 183–192, 2024.

[2] L. Chen, P. Chen, and Z. Lin, "Artificial intelligence in education: A review," *Ieee Access*, vol. 8, pp. 75 264–75 278, 2020.

[3] A. S. Anwar, U. Rahardja, A. G. Prawiyogi, N. P. L. Santoso, and S. Maulana, "ilearning model approach in creating blockchain based higher education trust," *Int. J. Artif. Intell. Res*, vol. 6, no. 1, 2022.

[4] G. Maulani, U. Rahardja, M. Hardini, R. D. I'zzaty, Q. Aini, and N. P. L. Santoso, "Educating farmers using participatory rural appraisal construct," in *2020 Fifth International Conference on Informatics and Computing (ICIC)*. IEEE, 2020, pp. 1–8.

[5] W. Sejati and V. Melinda, "Education on the use of iot technology for energy audit and management within the context of conservation and efficiency," *International Transactions on Education Technology*, vol. 1, no. 2, pp. 138–143, 2023.

[6] U. Rahardja, M. Ngadi, R. Budiarto, Q. Aini, M. Hardini, and F. P. Oganda, "Education exchange storage protocol: Transformation into decentralized learning platform," in *Frontiers in Education*, vol. 6. Frontiers Media SA, 2021, p. 782969.

[7] D. Sebastian, I. Sembiring, E. Sediyono, and K. D. Hartomo, "Literature review dan survey trend teknologi pengembangan website untuk website skala kecil," *INFORMATION SYSTEM FOR EDUCATORS AND PROFESSIONALS: Journal of Information System*, vol. 7, no. 2, pp. 185–194, 2023.

[8] S. Mehta and L. Magdalena, "Education 4.0: Online learning management using education smart courses," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 4, no. 1, pp. 70–76, 2022.

[9] I. T. Sanusi, F. J. Agbo, O. A. Dada, A. A. Yunusa, K. D. Aruleba, G. Obaido, O. Olawumi, S. S. Oyelere *et al.*, "Stakeholders' insights on artificial intelligence education: Perspectives of teachers, students, and policymakers," *Computers and Education Open*, vol. 7, p. 100212, 2024.

[10] Z. Hasanov, P. Antoniou, E. Suleymanov, and V. Garayev, "The impact of behavioural, cognitive and emotional dimensions of student engagement on student learning: the case of azerbaijani higher education institutions," *International Journal of Knowledge and Learning*, vol. 14, no. 1, pp. 10–38, 2021.

[11] Q. Aini, W. Febriani, C. Lukita, S. Kosasi, and U. Rahardja, "New normal regulation with face recognition technology using attendx for student attendance algorithm," in *2022 International Conference on Science and Technology (ICOSTECH)*. IEEE, 2022, pp. 1–7.

[12] N. Nuryani, A. B. Mutiara, I. M. Wiryana, D. Purnamasari, and S. N. W. Putra, "Artificial intelligence model for detecting tax evasion involving complex network schemes," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 3, pp. 339–356, 2024.

[13] D. S. S. Wuisan, R. A. Sunardjo, Q. Aini, N. A. Yusuf, and U. Rahardja, "Integrating artificial intelligence in human resource management: A smartpls approach for entrepreneurial success," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 5, no. 3, pp. 334–345, 2023.

[14] M. W. Wicaksono, M. B. Hakim, F. H. Wijaya, T. Saleh, E. Sana *et al.*, "Analyzing the influence of artificial intelligence on digital innovation: A smartpls approach," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 5, no. 2, pp. 108–116, 2024.

[15] E. M. Haryono, I. Gunawan, A. N. Hidayanto, U. Rahardja *et al.*, "Comparison of the e-lt vs etl method in data warehouse implementation: A qualitative study," in *2020 International Conference on Informatics, Multimedia, Cyber and Information System (ICIMCIS)*. IEEE, 2020, pp. 115–120.

[16] J. van der Merwe, S. M. Wahid, G. P. Cesna, D. A. Prabowo *et al.*, "Improving natural resource management through ai: Quantitative analysis using smartpls," *International Transactions on Artificial Intelligence*, vol. 2, no. 2, pp. 135–142, 2024.

[17] F. Faiqotuzzulfa and S. A. Putra, "Virtual reality's impacts on learning results in 5.0 education: a meta-analysis," *International Transactions on Education Technology*, vol. 1, no. 1, pp. 10–18, 2022.

[18] K. Mirdad, O. P. M. Daeli, N. Septiani, A. Ekawati, and U. Rusilowati, "Optimizing student engagement and performance usingai-enabled educational tools," *CORISINTA*, vol. 1, no. 1, pp. 53–60, 2024.

[19] P. Edastama, S. Purnama, R. Widayanti, L. Meria, and D. Rivelino, "The potential blockchain technology in higher education learning innovations in era 4.0," *Blockchain Frontier Technology*, vol. 1, no. 01, pp. 104–113, 2021.

[20] V. Agarwal, M. Lohani, and A. S. Bist, "A novel deep learning technique for medical image analysis using improved optimizer," *Health Informatics Journal*, vol. 30, no. 2, p. 14604582241255584, 2024.

[21] Q. Aini, D. Manongga, U. Rahardja, I. Sembiring, and A. U. Hasanah, "Scheme ilearning dapps for education using blockchain-based," in *2022 IEEE Creative Communication and Innovative Technology (ICCIT)*. IEEE, 2022, pp. 1–7.

[22] S. Wijaya, A. Husain, M. Laurens, and A. Birgithri, "ilearning education challenge: Combining the power of blockchain with gamification concepts," *CORISINTA*, vol. 1, no. 1, pp. 8–15, 2024.

[23] N. Ramadhona, A. A. Putri, and D. S. S. Wuisan, "Students' opinions of the use of quipper school as an online learning platform for teaching english," *International Transactions on Education Technology*, vol. 1, no. 1, pp. 35–41, 2022.

[24] E. C. Cheng and T. Wang, "Institutional strategies for cybersecurity in higher education institutions," *Information*, vol. 13, no. 4, p. 192, 2022.

[25] A. Bozkurt, X. Junhong, S. Lambert, A. Pazurek, H. Crompton, S. Koseoglu, R. Farrow, M. Bond, C. Nerantzi, S. Honeychurch *et al.*, "Speculative futures on chatgpt and generative artificial intelligence (ai): A collective reflection from the educational landscape," *Asian Journal of Distance Education*, vol. 18, no. 1, pp. 53–130, 2023.

[26] O. O. Ayeni, N. M. Al Hamad, O. N. Chisom, B. Osawaru, and O. E. Adewusi, "Ai in education: A review of personalized learning and educational technology," *GSC Advanced Research and Reviews*, vol. 18, no. 2, pp. 261–271, 2024.

[27] H. Luan, P. Geczy, H. Lai, J. Gobert, S. J. Yang, H. Ogata, J. Baltes, R. Guerra, P. Li, and C.-C. Tsai, "Challenges and future directions of big data and artificial intelligence in education," *Frontiers in psychology*, vol. 11, p. 580820, 2020.

[28] X. Zhai, X. Chu, C. S. Chai, M. S. Y. Jong, A. Istenic, M. Spector, J.-B. Liu, J. Yuan, and Y. Li, "A review of artificial intelligence (ai) in education from 2010 to 2020," *Complexity*, vol. 2021, no. 1, p. 8812542, 2021.

[29] Q. Aini, I. Dhaniarti, and A. Khoirunisa, "Effects of ilearning media on student learning motivation," *Aptisi Transactions On Management*, vol. 3, no. 1, pp. 1–12, 2019.

[30] O. A. Farayola, A. A. Abdul, B. O. Irabor, and E. C. Okeleke, "Innovative business models driven by ai technologies: a review," *Computer Science & IT Research Journal*, vol. 4, no. 2, pp. 85–110, 2023.

[31] S. Maghsudi, A. Lan, J. Xu, and M. van Der Schaar, "Personalized education in the artificial intelligence era: what to expect next," *IEEE Signal Processing Magazine*, vol. 38, no. 3, pp. 37–50, 2021.

[32] W. A. Nurasniar, "Employee performance improvement through competence and organizational culture with work motivation as a mediation variable," *APTISI Transactions on Management*, vol. 6, no. 2, pp. 121–131, 2022.

[33] U. Rusilowati, F. P. Oganda, R. Rahardja, T. Nurtino, and E. Aimee, "Innovation in smart marketing: The role of technopreneurs in driving educational improvement," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 5, no. 3, pp. 305–318, 2023.

[34] A. Phillips, J. F. Pane, R. Reumann-Moore, and O. Shenbanjo, "Implementing an adaptive intelligent tutoring system as an instructional supplement," *Educational Technology Research and Development*, vol. 68, no. 3, pp. 1409–1437, 2020.

[35] M. Siti *et al.*, "Wireless network security design and analysis using wireless intrusion detection system," *International Journal of Cyber and IT Service Management*, vol. 2, no. 1, pp. 30–39, 2022.

[36] A. N. Halimah and H. Abdullah, ""student preference towards the utilization of edmodo as a learning platform to develop responsible learning environments" study," *International Transactions on Education*

Technology, vol. 1, no. 1, pp. 53–58, 2022.

[37] M. Yang and F. Weng, "Ai-powered personalized learning journeys: Revolutionizing information management for college students in online platforms," *Journal of Information Systems Engineering and Management*, vol. 8, no. 1, p. 23196, 2023.

[38] S. T. Boppiniti, "Real-time data analytics with ai: Leveraging stream processing for dynamic decision support," *International Journal of Management Education for Sustainable Development*, vol. 4, no. 4, 2021.

[39] K. Srinivasa, M. Kurni, and K. Saritha, "Harnessing the power of ai to education," in *Learning, teaching, and assessment methods for contemporary learners: pedagogy for the digital generation*. Springer, 2022, pp. 311–342.

[40] T. M. Singh, C. K. K. Reddy, B. R. Murthy, A. Nag, and S. Doss, "Ai and education: Bridging the gap to personalized, efficient, and accessible learning," in *Internet of Behavior-Based Computational Intelligence for Smart Education Systems*. IGI Global, 2025, pp. 131–160.

[41] H. Alamri, V. Lowell, W. Watson, and S. L. Watson, "Using personalized learning as an instructional approach to motivate learners in online higher education: Learner self-determination and intrinsic motivation," *Journal of Research on Technology in Education*, vol. 52, no. 3, pp. 322–352, 2020.

[42] O. Amah and V. O. Okesipe, "Ai in education: Ethical challenges and opportunities," *Integrating Artificial Intelligence in Education: Enhancing Teaching Practices for Future Learning*, pp. 1–26, 2025.